

FIG 5—Method of turning casualty to recovery position

before giving another inflation. This should normally take two to four seconds. Each sequence of 10 breaths will therefore take about 40 to 60 seconds.

The exact timing of expiration is not critical; wait for the chest to fall, then give another inflation.

#### CHEST COMPRESSION

There is no evidence that an initial precordial (chest) thump improves survival in an unwitnessed cardiac arrest. On the other hand, a witnessed or monitored cardiac arrest may successfully be terminated by a thump, and a thump is recommended as part of the advanced life support protocol.<sup>1</sup>

There is no convincing evidence that success of cardiopulmonary resuscitation is influenced by the rate of chest compressions within the range 60-100/min.

Accordingly, compressions should be given at a target (mean) rate of 80/min. For assessment, however, a range of 60-100 compressions/min would be acceptable. This is the rate or speed at which compressions should be undertaken, not the absolute number of compressions delivered within a given minute.

It is essential to combine ventilation with chest compression in order that the blood, which is being artificially circulated, contains enough oxygen.

In an unconscious adult the rescuer should aim to press down some 4-5 cm and apply only enough pressure to achieve this.

At all times the pressure should be firm, controlled, and applied vertically. Erratic or violent action is dangerous.

Try to spend about the same time in the compressed phase as in the released phase.

As the chances are remote that effective spontaneous cardiac action will be restored by cardiopulmonary resuscitation without other techniques of advanced life support (including defibrillation),<sup>1</sup> time should not be wasted by further checks for a pulse. If, however, the casualty makes a movement or takes a spontaneous breath check the carotid pulse to see whether the heart is beating; take no more than five seconds. Otherwise *do not interrupt* resuscitation.

Much of the content of this article has been published in *Resuscitation*.<sup>2</sup>

*Members of the working group were:* Stig Holmberg (Sweden; chairman), Anthony Handley (England; secretary), Jan Bahr (Germany), Peter Baskett (England), Leo Bossaert (Belgium), Douglas Chamberlain (England), Wolfgang Dick (Germany), Ank van Drenth (Netherlands), Lars Ekstrom (Sweden), Rudolf Juchem (Germany), Dietrich Kettler (Germany), Andrew Marsden (Scotland), Oliver Moeschler (Switzerland), Koen Monsieurs (Belgium), Paul Petit (France), Hribar Primoz (Bosnia), Jurgen Schuttler (Germany).

1 European Resuscitation Council Working Party. Adult advanced cardiac life support: the European Resuscitation Council guidelines 1992 (abridged). *BMJ* 1993;306:1589-93.

2 Basic Life Support Working Party of the European Resuscitation Council. Guidelines for basic life support. *Resuscitation* 1992;24:103-10.

## Adult advanced cardiac life support: the European Resuscitation Council guidelines 1992 (abridged)

European Resuscitation Council Working Party

The European Resuscitation Council, established in 1990, is committed to saving lives by improving standards of cardiopulmonary resuscitation across Europe and coordinating the activities of interested organisations and individuals. In this regard the council has successfully brought together physicians and surgeons from eastern and western Europe and, in addition, has established relations with the American Heart Association and equivalent organisations in Canada, Australia, and South Africa. A main objective of the European Resuscitation Council is to produce guidelines for cardiopulmonary and cerebral resuscitation, and in this paper members of a working party of 14 experts from 11 countries set out an abridged version of the council's guidelines for adult advanced cardiac life support. The council hopes that the guidelines and accompanying algorithms will serve as a ready use "how to do it" for ordinary practitioners and paramedics inside and outside hospital.

The European Resuscitation Council presented guidelines for adult basic and advanced cardiac life

support at its first scientific congress in 1992. Three principles were held to be important in the production of the guidelines. The first was a willingness to review comprehensively the evidence justifying existing recommendations. The second was an emphasis on minimising delay in delivering defibrillating shocks to the victims of ventricular fibrillation. The third was the need for simplicity in treatment algorithms. In addition, the guidelines were to be appropriate for semiautomated or automated defibrillators and for use both in hospital and in pre-hospital settings.

Draft guidelines were submitted for comment to representatives of national societies with affiliation to the European Resuscitation Council. After appropriate modifications they were approved by the executive committee of the council. The guidelines have been published in preliminary form,<sup>1,2</sup> together with papers summarising the scientific evidence on which they were based.<sup>3-12</sup> This paper sets out an abridged version of the guidelines for adult advanced cardiac life support aimed at promoting their implementation. Abridged and complete versions will also be published in other European journals.

#### European Resuscitation Council

Members of the working party are listed at the end of this report.

Correspondence to:  
Dr Douglas Chamberlain,  
Royal Sussex County  
Hospital, Brighton  
BN2 5BE.

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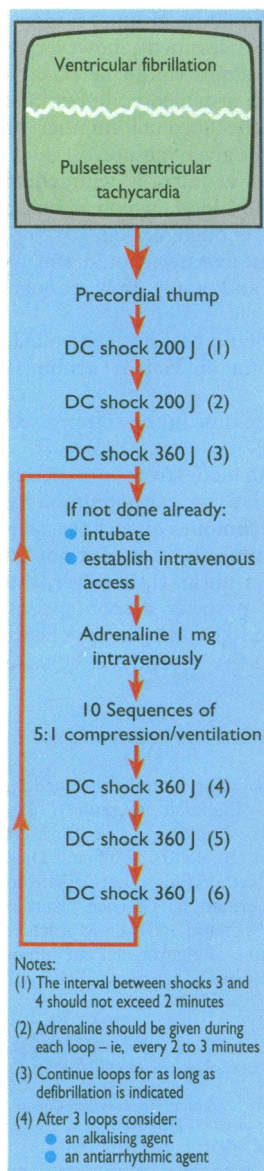


FIG 1—Algorithm for managing ventricular fibrillation or pulseless ventricular tachycardia

## The arrhythmias of cardiac arrest

Cardiac arrest is the cessation of cardiac mechanical activity, confirmed by the absence of a detectable pulse, unresponsiveness, and apnoea (or agonal respirations). In adults the commonest cause is primary ischaemic heart disease. Cardiac arrest may be associated with any of four heart rhythms: ventricular fibrillation, pulseless ventricular tachycardia, asystole, or electromechanical dissociation.

*Ventricular fibrillation* is by far the commonest primary rhythm of cardiac arrest, especially in victims of sudden, unheralded cardiac death. *Pulseless ventricular tachycardia* may occur first, but usually deteriorates rapidly to ventricular fibrillation. The two conditions are treated identically. If managed appropriately and promptly most patients with these rhythms can survive to hospital discharge, but only rarely can these conditions be met. Prospects for survival decrease by roughly 5% a minute even with effective basic life support, and delay to defibrillation is the most important determinant of success or failure.

*Asystole* is the primary rhythm in up to a quarter of cardiac arrests in hospital and 10% of those outside hospital. It is seen most commonly, however, as the end result in patients with ventricular fibrillation who have not been resuscitated successfully.

*Electromechanical dissociation* is a term that implies absence of mechanical activity or undetectable activity in the presence of a continuing coordinated waveform in the electrocardiogram. It is diagnosed infrequently in pre-hospital victims of cardiac arrest (except when caused by trauma), partly because a coordinated electrocardiographic waveform can persist only transiently in the absence of coronary flow. Patients with electromechanical dissociation or asystole usually have a survival rate less than 5% when the condition is caused by heart disease. Higher survival rates have been reported when these rhythms are associated with hypothermia, near drowning, or drug overdose.

The description of the management of cardiac arrest given below assumes that in appropriate cases basic life support has been instituted and will be continued during the resuscitation attempt.

## Management of ventricular fibrillation

Figure 1 shows the algorithm for treating ventricular fibrillation or pulseless ventricular tachycardia. The need to achieve defibrillation as rapidly as possible cannot be overemphasised. If circumstances permit immediate defibrillation—for example, in a high dependency area with a rapidly charging defibrillator to hand—only a single precordial thump should be tried rather than basic life support measures. This takes no more than two or three seconds and need not delay preparations for electrical defibrillation. If the thump can be given within 30 seconds of the loss of cardiac output, then the conversion from mechanical to electrical energy may be enough to restore an effective rhythm in up to 40% of cases of ventricular tachycardia and roughly 2% of cases of ventricular fibrillation. Concern that a precordial thump may accelerate tachyarrhythmia or precipitate ventricular fibrillation is invalid in a patient already in cardiac arrest. The risk of these complications is outweighed by the potential for rapid conversion of a life threatening arrhythmia.

If the precordial thump is unsuccessful electrical defibrillation must follow immediately. One paddle should be placed below the outer half of the right clavicle, and the other just outside the usual position of the cardiac apex (V4-5 of the electrocardiogram). The polarity of the electrodes is unimportant. Conductive gel pads or jelly and firm pressure must be used to ensure good contact. The sequence of energies recommended for the first three shocks is conventional:

200 J, 200 J, and 360 J. Provided that these shocks can be delivered quickly (within 30 to 45 seconds), then the sequence should not be interrupted by basic life support measures. Ideally, for safety, the electrodes should be left on the chest when rapid sequences of shocks are given. Some check of rhythm or pulse must be made after each shock, the method depending on the type of equipment being used.

With manual defibrillators a pulse should be sought. If it is absent the defibrillator should be recharged without waiting for the monitor tracing to return because the delay may be appreciable. Electrocardiographic confirmation on the monitor is desirable, however, immediately before the next shock. With automated defibrillators feeling the pulse delays the diagnostic algorithm by introducing artefact. For most shocks reliance should therefore be placed on the machine, which will indicate whether another shock is required. Palpation is restricted to the start of each loop—once every third defibrillator discharge. If the time to charge the defibrillator is unduly prolonged one or two sequences of basic life support (if there are two rescuers: five chest compressions to one breath) should be given between shocks.

When the first three shocks are unsuccessful the prospects of recovery are not hopeless, and attempts should continue if this strategy is appropriate clinically. As restoration of coordinated rhythm will inevitably be delayed, if it occurs at all, the priority must change to preserving cerebral and myocardial perfusion by the best possible basic life support.

### PROCEDURE WHEN FIRST THREE SHOCKS HAVE FAILED

If not achieved already, brief attempts should be made to intubate the patient and gain intravenous access. In most settings these procedures will be attempted simultaneously by two operators. Neither procedure should be allowed to cause undue delay in continuing basic life support or giving further shocks. The person in charge of the resuscitation should allow a limited time—ideally, not more than 15 seconds—before chest compression and ventilation are continued, using 10 sequences of five compressions to one breath, while preparations are made for a new set of shocks—each to deliver 360 J. Adrenaline should be given before the shocks (provided that intravenous or endotracheal access is available), but there is no need to delay the shocks for drugs to become effective. Adrenaline is given principally to increase the efficacy of basic life support, not as an adjuvant to defibrillation.

Thereafter, the loop should be repeated. If intubation or intravenous access, or both, have not already been achieved or if either needs revision each loop presents an opportunity for another attempt—but always without delaying the basic life support procedures or the delivery of shocks.

With each loop 1 mg adrenaline should be given intravenously. This implies a dose of 1 mg every two to three minutes if shocks are given without delay. This is not excessive, given the high endogenous concentrations of adrenaline during cardiac arrest. Nothing is gained by deferring further shocks, because defibrillation is still the only intervention capable of restoring a spontaneous circulation. The prospects of success become progressively poorer, and other interventions can do no more than slow the decline in the odds of success.

After every three loops other drugs may appropriately be used. An intravenous alkalinising agent (such as sodium bicarbonate up to 50 mmol) should be considered at this stage—when acidosis may be a problem despite adequate ventilation and compression. Thereafter, an alkalinising agent should be considered again every three loops, but ideally given only in the knowledge of the arterial or central venous pH and



bicarbonate value (or alternatively of base deficit). In addition to sodium bicarbonate, antiarrhythmic agents may be given every three loops within the guidelines—though, given existing evidence, they are not mandatory. Lignocaine, bretylium, and amiodarone have all been advocated for this, now desperate situation.

The possibility of a change of paddle position (usually to anteroposterior) or even a change of defibrillator should be considered for all patients with refractory ventricular fibrillation.

The use of calcium, magnesium, or potassium salts for special purposes has also been advocated during the management of cardiac arrest. The algorithm (fig 1) is not intended specifically to deny their use either for known deficiencies in any patient or (after the first three loops) empirically. No evidence exists in favour of these or other agents, and calcium is implicated in ischaemic tissue injury.

The number of loops to be used in any resuscitation is a matter of judgment, having regard to the clinical situation and the perceived prospect remaining of a successful outcome. A resuscitation attempt may reasonably last for any time from 10 minutes to an hour. Resuscitation that was started appropriately should not usually be abandoned while the rhythm is still recognisable ventricular fibrillation. The development of persistent asystole is a useful indication that prospects for success are slight. Few situations call for efforts to be continued for over an hour; exceptions include hypothermia, near drowning, and drug intoxication.

It is the role of the team leader to ensure the safety of all the team members during defibrillation. In addition to the electrical hazards, care must be taken to remove all glyceryl trinitrate patches or ointments from the chest wall to prevent explosions.

### Management of asystole

Figure 2 shows the algorithm for the management of asystole. Including a precordial thump for asystole is not controversial, though it is unlikely to have any relevance after a period of basic life support.

The prospect of recovery from asystole is poor except in cases of trifascicular block (where P waves may be seen), in cases evolving from extreme bradycardia, and in cases where the rhythm is transient after defibrillation. An important additional consideration is the possibility of mistaken diagnosis. This may not be uncommon. A waveform of ventricular fibrillation may be missed or not be recognised for various reasons, including equipment failure, excessive artefact, uncontrollable movement—as in a moving ambulance or aircraft—or an incorrect gain setting. Even an unusually directional vector of a fibrillation waveform that happens to be perpendicular to the sensing electrode can lead to ventricular fibrillation being mistaken for asystole.

Because ventricular fibrillation is so readily treatable, and because treatment is so much more likely to be successful than is the management of asystole, it is usually worth spending a short time treating fibrillation that may or may not be present. Little harm will result, and the delay in using other measures should be slight. The possibility of a successful resuscitation that otherwise would be impossible is real.

**Caution**—If the waveform is, indeed, that of asystole or fine ventricular fibrillation, defibrillation in the automated mode will be unsuccessful because the machine will determine that a shock is inappropriate. Time should not be wasted by persevering in these attempts with an automated defibrillator.

The defibrillation sequence, if used, is followed by intubation, securing intravenous access, and giving drugs. As in the defibrillation algorithm (fig 1), the

rationale for the adrenaline is to enhance basic life support. Atropine will counter any excess vagal tone, although it brings no proved benefit in clinical practice. Atropine is used in a dose that blocks vagal tone fully under normal circumstances (3 mg), but only one dose is recommended. As in the defibrillation algorithm, undue delay in performing basic life support must be avoided.

Once these steps have been taken pacing should be considered, but only if electrical activity (P waves or occasional QRS complexes) has recently been present. The choice between per-venous and transcutaneous pacing as the initial strategy depends in part on the local availability of equipment and skills.

In the absence of electrical activity further loops should be considered. These include further doses of adrenaline and cycles of basic life support as in the ventricular fibrillation protocol. If no response has been obtained after three cycles high dose adrenaline (5 mg) should be considered, though its value is unproved. Careful consideration should be given before undertaking prolonged resuscitation in patients with asystole. After 15 minutes of asystole recovery rarely occurs.

### Management of electromechanical dissociation

Electromechanical dissociation implies continued electrical activity of the heart without mechanical activity. A definite diagnosis can rarely be made clinically because feeble contraction of the heart may also fail to produce a pulse, detectable heart beat, or heart sounds. But absence of mechanical activity and undetectable mechanical activity carry an equally poor prognosis except when they are transient during a cardiac arrest or when there is a specific remediable cause. Search for and recognition of specific and correctable causes of the clinical picture of electromechanical dissociation are therefore of prime importance. The principal causes of electromechanical dissociation are listed in the algorithm (fig 3).

If no evidence exists for any of the specific causes cardiopulmonary resuscitation should be continued with the usual associated procedures of intubation, establishing venous access, and treatment with adrenaline. No recommendation based on sound scientific evidence can be made for routine use of calcium salts or alkalinising agents, though in some circumstances they may possibly be of value.

### Airway management

Tracheal intubation is the preferred technique for airway control during cardiopulmonary resuscitation. Advantages include isolation of the airway, prevention of aspiration and avoidance of gastric dilatation, facilitation of mechanical ventilation, and the delivery of high oxygen concentrations. Suction of the trachea and major bronchi and delivery of drugs via the endotracheal route are also possible. Provided that tracheal intubation is performed by experienced operators the success rate is high, the time to perform the procedure minimal, and complications uncommon. Confirmation of correct tracheal tube position should be performed by visualising the glottis through a laryngoscope, listening to breath sounds bilaterally over the chest and upper abdomen, and watching the chest for symmetrical expansion during ventilation.

End tidal carbon dioxide measurement may be used as an aid to confirm correct tube placement and also indirectly to measure cardiac output during cardiopulmonary resuscitation. The highest possible inspired oxygen concentration should be given during ventilation. The use of self inflating bag-valve devices with a reservoir bag allows oxygen enrichment and the

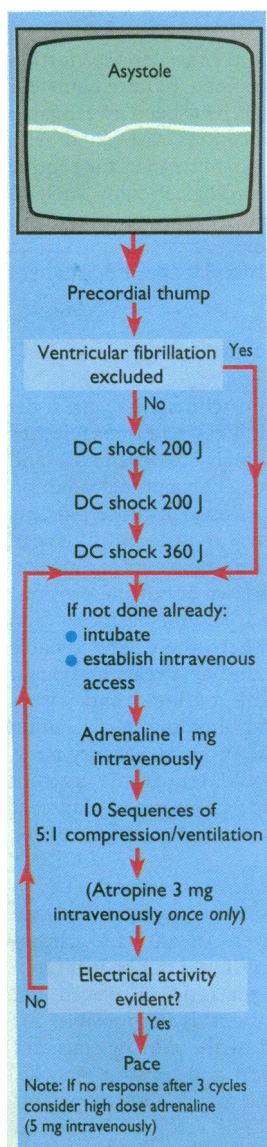


FIG 2—Algorithm for managing asystole



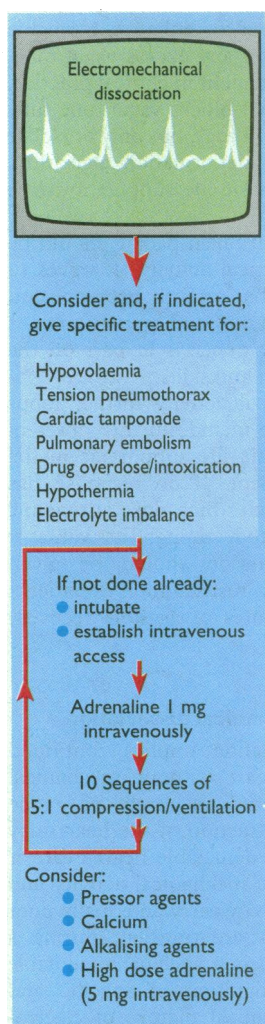


FIG 3—Algorithm for managing electromechanical dissociation

delivery of fractional inspiratory oxygen concentrations of around 90%. When mechanical ventilators are used 100% oxygen concentrations can be achieved. A tidal volume of 10 ml/kg with a respiratory rate of 12-15/min and an inspiratory to expiratory ratio of 1:2 or 1:1.5 is advised.

### Drug delivery routes

Because of the importance of defibrillation the delivery of subsequent shocks must not be delayed by difficulties in securing an access route for drugs. The venous route is recommended for drug delivery during cardiac arrest. Peripheral venous cannulation is rapid, safe, and does not interfere with cardiopulmonary resuscitation. Cannulation of an antecubital vein is the site of choice, although the external jugular vein is an alternative. Drug delivery from any peripheral vein should be propelled by a fluid flush of 20 ml or more to expedite entry to the circulation. Central venous cannulation can more rapidly deliver drugs to the central circulation. However, the procedure requires considerably greater skill and has higher associated risks, including inadvertent arterial puncture, haemothorax, and pneumothorax. A central venous route has additional serious hazards after thrombolytic therapy.

Although the endotracheal tube is often the first available route of access during cardiopulmonary resuscitation, it should be considered a "second line" approach. Drug absorption from the bronchial tree may be impaired by atelectasis, pulmonary oedema, and—in the case of adrenaline—local vasoconstriction produced by the drug itself. If the endotracheal route is used drug doses of two to three times greater than for the intravenous route should be diluted with isotonic saline to a total of 10 ml and instilled deeply via a catheter. The pharmacodynamics of the drugs cannot be predicted accurately with this route, however, because of the many additional and uncontrollable variables that are introduced. After dosing, the patient should be given five inflations to maximise absorption from the distal bronchial tree.

### Open chest cardiac massage

Open chest cardiac massage is only rarely indicated in advanced cardiac life support for a patient with a "medical" cardiac arrest, though emergency thoracotomy in cases of trauma is a well validated procedure for which clear indications exist. Further studies are warranted to delineate those groups of medical patients who are most likely to benefit from an open chest approach and to define the optimal timing of this intervention. Indications may exist where conventional chest compression may rapidly be seen to be ineffective—for example, in patients with mechanical hindrance to blood flow, as in tight aortic stenosis—or when defibrillation is intrinsically difficult, as in some cases of drug toxicity or in severe hypothermia. At present, however, no firm recommendations can be made.

### Post-resuscitation care

After successful initial resuscitation all patients should be treated in an intensive care type of environment. Airway patency and adequacy of ventilation with correction of hypoxia and prevention of hypercapnia are crucial to minimise further tissue injury during the reperfusion phase. Regular blood gas analysis should be performed, and pulse oximetry may be used to assess oxygen saturation non-invasively. Electrolyte concentrations should be measured urgently. Blood glucose concentrations should be monitored and kept at low normal in comatose patients.

Infusion of glucose is indicated only for known

hypoglycaemia. Electrocardiographic monitoring should be continued. Specific arrhythmias will require treatment if associated with haemodynamic disturbance. The use of lignocaine prophylactically after cardiac arrest caused by ventricular fibrillation is controversial. Its use will depend on the balance between the negative inotropic effects of the drug and the potential benefits of malignant arrhythmia suppression. Whenever any drug is given to a patient after a cardiac arrest it should be remembered that the normal pharmacokinetic profile is likely to be disturbed owing to impaired hepatic and renal function.

Autoregulation of cerebral blood flow is deranged for some time after circulatory arrest. During this period flow is linearly related to the perfusion pressure and there is poor tolerance to variations in blood pressure. It is important, therefore, to maintain arterial pressures close to the norm for the patient to prevent hypotensive hypoperfusion as well as excessive pressures which may lead to cerebral oedema. Correction of hypoxia, hypercapnia, and pain are important in relation to these aspects. Severe hypotension may require volume expanders or vasopressors. Convulsions increase cerebral metabolic requirements and intracranial pressures and can cause brain damage. Seizures should be controlled with an anticonvulsant such as diazepam, phenytoin, barbiturates, or other agents. Observations should then include electroencephalography. Sedative and analgesic drugs should be used as in any intensive care setting to treat anxiety and relieve discomfort. Exaggerated or prolonged sedation is not indicated and may create further problems in diagnosis and prolong requirements for ventilatory support. Many drugs have been investigated for reducing cerebral complications associated with cardiac arrest. None can be recommended for routine use at present. Although neurological signs such as absent pupillary reflexes suggest a poor prognosis, abnormalities early after cardiac arrest do not always indicate irreversible neuronal damage and permanent brain impairment.

### Ethics of resuscitation

A large proportion of patients with cardiac arrest die whatever procedures are used. They and their relatives may be exposed inappropriately to dramatic and sometimes undignified efforts. The optimal solution would be to start resuscitation only in those patients with potential for long term survival, but this can rarely be determined early on. For out of hospital cardiac arrests little may be known about the previous medical condition of the patient and the basic rule is to start resuscitation except when there are reliable criteria of certain death. For cardiac arrests that occur in hospital a patient's medical condition and wishes have often been defined. Withholding resuscitation may then be appropriate if the prognosis is very poor, if the patient's condition would render the attempt futile, or if the patient had made an informed judgment that he or she did not wish resuscitation to be attempted.

The commonly used "Do not resuscitate" (DNR) order may be confusing. It may be safer to state unequivocally that "in the event of an acute cardiopulmonary arrest resuscitation should not be instituted or continued." When such an order is placed the physician caring for the patient is responsible for ensuring that it is understood by the nursing staff and written formally in the medical and nursing records. The rationale for the order and any role of the patient in making that decision should be recorded. It should be reviewed promptly in response to any relevant change in circumstances. When it is appropriate to do

so, the decision to discontinue advanced cardiac life support should be made by the physician in charge, but all others involved in the attempt should usually be consulted.

*Members of the working party were:* Douglas Chamberlain (England; chairman), Leo Bossaert (Belgium), Pierre Carli (France), Erik Edgren (Sweden), Lars Ekstrom (Sweden), Svein Hapnes (Norway), Stig Holmberg (Sweden), Rudy Koster (Netherlands), Karl Lindner (Germany), Vittorio Pasqualucci (Italy), Narciso Perales (Spain), Martin von Planta (Switzerland), Colin Robertson (Scotland), Petter Steen (Norway).

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## Withholding cardiopulmonary resuscitation: proposals for formal guidelines

Len Doyal, Daniel Wilsher

**Working with members of the Royal London Trust and its medical council, Len Doyal and Daniel Wilsher have composed a set of guidelines governing the making of decisions to withhold resuscitation from patients. The guidelines describe the procedures that should be followed when giving orders for non-resuscitation and the clinical, legal, and moral criteria that should be satisfied before such orders are issued. The authors hope that these guidelines will be of help to those responsible for the creation of hospitals' policies for non-resuscitation.**

Although there has been some discussion in the United Kingdom of hospital policy on withholding cardiopulmonary resuscitation from patients who suffer cardiac arrest, no consensus has yet emerged.<sup>1-3</sup> Generally decisions continue to be taken according to the clinical judgment of those caring for a patient without regard to more formal guidelines. Over the past year this informal approach has come under scrutiny, largely as a result of a letter sent by the chief medical officer to all consultants in England and Wales. This asked for the formulation of clear policies on the making of decisions to withhold resuscitation.<sup>4</sup> The chief medical officer further indicated that consultants should make their policy clear to all junior staff. His letter was precipitated by the upholding of a complaint made to the parliamentary ombudsman by the son of an elderly woman who had been given "Not for resuscitation" status by a junior doctor without consultation.<sup>5</sup>

There is evidence that this was not an isolated incident. A study conducted in a district general hospital suggested that considerable confusion existed over the resuscitation status of patients.<sup>6</sup> Decisions were poorly documented or in some cases not documented at all. This meant that nursing staff were unaware of some patients' not for resuscitation status, potentially resulting in inappropriate cardiopulmonary resuscitation. Discussions with colleagues suggest that arbitrary differences may exist in assigning not for resuscitation status depending on the specialty of the consultant in charge.

### Professional and legal duty to act to save life

It has been argued that a failure to attempt resuscitation is an omission and therefore acceptable because

"nothing" is done. Nature is allowed to take its course. This argument has little legal or moral basis.<sup>7</sup> In general, when there is a recognised professional duty to act to save life, not to do so in the face of cardiac arrest is a prima facie breach of the law. Morally an omission constitutes a choice, itself an action, which may or may not be culpable. Like any other actions, omissions must therefore be justified by the acceptability of their consequences—in this instance the death of a patient. If there was evidence that such a patient might have survived resuscitation the doctor who issued the not for resuscitation order could face criminal proceedings. This would depend, in part, on whether reasonable grounds existed for the decision not to resuscitate. Even if the physician was found not guilty further charges of professional misconduct might be brought by the General Medical Council.

Clarification about what constitutes a legally and morally appropriate policy for cardiopulmonary resuscitation is therefore required. There is some relevant case law specifying the circumstances under which it is legitimate to withhold life prolonging treatment. Morally, the increasing emphasis within medicine on respect for individual autonomy potentially clashes with a tradition of clinical discretion, which continues to deprive patients of any knowledge of their cardiopulmonary resuscitation status. If such discretion is to be justified it must be against a background of acceptable legal and moral principles.

The BMA, in conjunction with the Royal College of Nursing, has recently published a policy on non-resuscitation.<sup>8</sup> While helpful in some respects, it lacks the clarity and completeness necessary to inform good clinical practice. Our aim in this paper is to formulate and defend more comprehensive guidelines, which can be incorporated into publicly stated policies for cardiopulmonary resuscitation within British hospitals.

### Grounds for non-resuscitation

There are three occasions when we consider non-resuscitation to be acceptable. The first is when patients deemed competent to give informed consent to medical treatment indicate that they refuse resuscitation after having been told about the probable consequences of cardiac arrest and resuscitation. This might be done by means of an "advanced directive," given recent judicial approval of this concept.<sup>9</sup> The

Joint Department of  
Human Science and  
Medical Ethics, London  
and St Bartholomew's  
Hospitals' Medical  
Colleges, London E1 2AD  
Len Doyal, senior lecturer in  
medical ethics  
Daniel Wilsher, King's Fund  
research fellow in medical  
ethics

Correspondence to:  
Mr Doyal.

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